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Information-Analytical System for Forecasting Indicators of the Social and Economic Sphere of the Russian Federation

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Abstract:

Currently, the need for the real-time evaluation of the functioning effectiveness of the subjects of the Russian Federation is observed. To achieve this goal, the situation centers, able to perform the monitoring of the socio-economic indicators both at the federal and regional levels, are created in Russia.

At the same time, it is necessary to implement the information-analytical system to make forecasts for the following periods, as well as to conduct a plan-fact analysis based on the available data, using various methods. In the framework of this study, the situation center of Federal State Budgetary Educational Institution of Higher Education "Plekhanov Russian University of Economics" (FSBEI HE "Plekhanov RUE") is considered.

The development of the information-analytical system based on a hybrid forecasting model, integrated with the software of the center under consideration, is proposed by the authors. The examples of the calculations and the estimation of their accuracy and quality, obtained with the prototype of the system under development, are presented.

Keywords: *econometric models, mathematical simulation of the economic systems, neural network simulation, forecasting, information-analytical system, situation center.*

JEL Classification: *O10, P50*

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1. Introduction

With the transition of the Russian Federation to the system of national accounting, the need appeared to develop new models of decision support based on the analysis of socio-economic indicators. These models formed the basis for information and analytical systems developed for the assessment of the regions of the country in order to build the rating of the subjects of the Russian Federation. The need to create these systems is due to the development of situation centers in the territory of the Russian Federation, which should provide an opportunity for the users to monitor the dynamics of a large volume of indicators, as well as to compare the targets (planned values) with actual ones and to monitor the socio-economic indicators both at the federal and regional levels. This will make it possible to respond in a timely manner to the changing situation in the region and to identify the critical value of the analyzed indicators and, therefore, to make timely decisions in a down economy.

In 2012, the Situation Center for Social and Economic Development of the Regions was established at the Plekhanov Russian University of Economics within the framework of the program for innovative development at the university. This center makes it possible to study the socio-economic indicators using a set of aids for data analysis. This center has a standard set of software for intelligent data visualization, report construction in various profiles; however, it lacks the models for forecasting.

The purpose of this study is to create an information-analytical forecasting system based on the hybrid forecasting model for the socio-economic indicators of the Russian Federation, which it will be integrated with the software of the situation center.

2. Methods

The developed information-analytical forecasting system for the socio-economic indicators of the Russian Federation should meet the requirements of accuracy and quality of the results obtained, be able to perform the calculations both at the regional and at the federal level, and also it should give the opportunities to perform the verification of the models constructed. This system is based on a hybrid forecasting model (Danko, Kitova, Kolmakov, Dyakonova, Grishina, & Sekerin, 2016, which includes a classical econometric model (regression model), as well as machine learning models and methods of artificial intelligence (neural networks, fuzzy logic, decision trees, Kohonen maps) (Grishin, Abdikeev, Kolmakov, Voronova, Turlak, & Filippov, 2010; Kolmakov, Kosorukov, Kitova, Antipov, Desyatov, & Sharafutdinova, 2012; Savinova, 2014; Johnston & DiNardo, 1997; Kossova, Kossova and Sheluntcova, 2014; Hanias *et al.*, 2017; Thalassinos *et al.*, 2009; 2012; 2013; Thalassinos and Pociovalisteanu, 2007).

A hybrid forecasting model is developed by the author collective of the Informatics Department. It includes more than 600 indicators (Pindyck & Rubinfeld, 1999) and

allows building medium- and short-term forecasting models (Hastie, Tibshirani & Friedman, 2009; Kitova, Kolmakov & Dyakonova, 2014; Savinova, 2016; Danilina, Gaifutdinova, & Kuznetsof, 2015). The composition and the structure of the information base for the system of models are based on the official data provided by the Federal State Statistics Service, the Central Bank of Russia, and the Ministry of Finance of the Russian Federation. The functionality of a system developed on the basis of the model described should include:

1. The automatic data uploading into the system.
2. The data quality research.
3. The selection and construction of a suitable model.
4. The calculation of the forecasted values of indicators.
5. The verification of the model obtained (calculation of the accuracy and quality indicators).
6. The construction of graphs.
7. The downloading of the data obtained.

With the help of this system, it is possible to make calculations both at the federal and regional levels. It is also possible to perform the calculations using the time series with different time intervals (month, quarter, year).

Currently, the prototype of the system being developed is the "Hybrid Intelligent Economic System" (HIES). It is implemented by means of VBA (Visual Basic application) and includes the construction of a linear regression model with various scenario conditions (Zhang, 2004), making it possible to perform the forecasting (Haykin 1998). The capabilities of the given system are considered in the scientific works of Kolmakov, Kitova and Dyakonova (2014), Kitova, Kolmakov, & Sharafutdinova (2013), Kitova, Kolmakov, & Dyakonova (2015), Denisova, Rukina, Samoylova & Takmazyan (2017) and Stroeva, Mironenko, Lyapina and Petrukhina (2016).

3. Results

Currently, 57 equations for the indicators of the social field of the Russian Federation are constructed within the system (Bishop, 2006) and their verification is carried out (Russell & Norvig, 1995; Rokach & Maimon, 2014). Based on the equations obtained, the forecast for 2015 is calculated. With the advent of the data for 2015, it became possible to verify this model. An example of the calculation is shown in Figure 1. As an example, the calculation of the indicator "Average monthly nominal accrued wages in Vladimir Oblast", in rubles (AMAW) is performed. As a result of verification, the following results are obtained (Table 1).

The values for the accuracy and quality criteria, under which the results obtained are considered acceptable, are chosen expertly (Table 2).

Figure 1. *Verification of the constructed forecast "Average monthly nominal accrued wages in Vladimir Oblast for 2016 calculated using the regression model"*

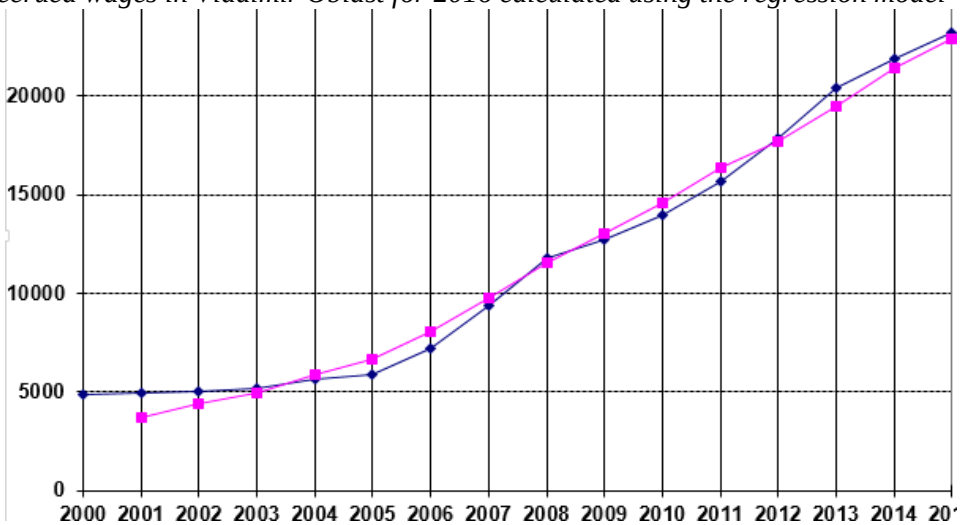


Table 1. *Verification result*

R2 (determination coefficient)	DW (Durbin-Watson criterion)	F-stat (Fisher statistics)	Relative error
0.99031597	1.64	374.9	1.4%

Table 2. *Estimation criteria for the equations*

Determination coefficient (R2)	> 0.4
F-stat values (F-stat)	> 4.0
Durbin-Watson criterion (DW)	0.6 < DW < 3.4

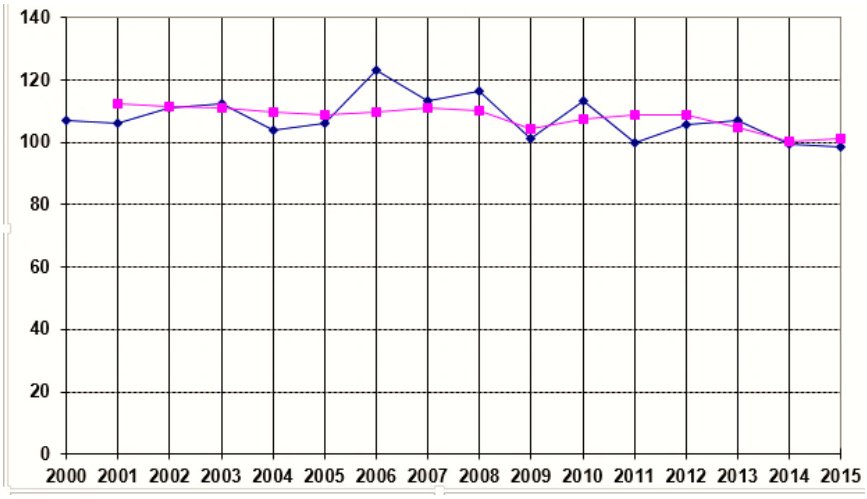
The accuracy is considered high if the relative error is less than 10%, it is considered acceptable, if the relative error is more than 10%, but less than 15%, and it is considered low if the relative error exceeds 15%. Thus, the forecast obtained is considered acceptable by the accuracy criterion and the model constructed is of high quality. As a result of the calculation of all the equations of this model and its further verification, the following result is obtained:

It can be noted that all the equations constructed are of the acceptable accuracy. However, the quality of the models obtained is insufficient. The indicator of this, for example, is the "Actual monetary incomes of the population of the Vladimir oblast in percentages as compared to the previous year" (RMI). In this case, the intelligent forecasting models, in particular, the artificial neural networks, can be used (see 9, 10). The results of the calculations of the regression and neural network models are presented in Figures 2 and 3, respectively. The multilayer perceptron with one hidden layer, on which 2 neurons are located, is selected as the neural network architecture. The method of training is Back propagation.

Table 3. *The verification result for the regression social field equations*

		Accuracy criterion		
		High	Middle	Low
Quality criterion	High	, Ex, Nal, $/p, SEI, Im, IVPT, Rmbc, RMO, IP1, IP3, FT, TIE, PBT2, CK1, CK2, CK3, CKD1, CKD2, CKG1, CKG2, SE, MIP, PI1, PI2, W2, Propin2, NW1, NW2, TRT1, TRT2, PR2, MESP, C1, CPD1, CPD2, SBER1, VAL1, VAL2, AMAW(39)		
	Low	, K$, ip, DFB%, FS, CE3, CE1, CE2, PBT1, TI1, TI2, GI1, GI2, W1, Propin1, PR1, C2, SBER2, RMI1(18)		

Figure 2. *The calculation of the indicator "Actual monetary incomes of the population of the Vladimir oblast" (in percentages as compared to the previous year) by means of the regression model*



As a result of verification, the following values for the criteria are obtained (Table 4). Thus, using the artificial neural network, it is possible to improve the quality without detriment to the accuracy.

Figure 3. *The calculation of the indicator "Actual monetary incomes of the population of Vladimir oblast" (in percentages as compared to the previous year) by means of the artificial neuron networks*

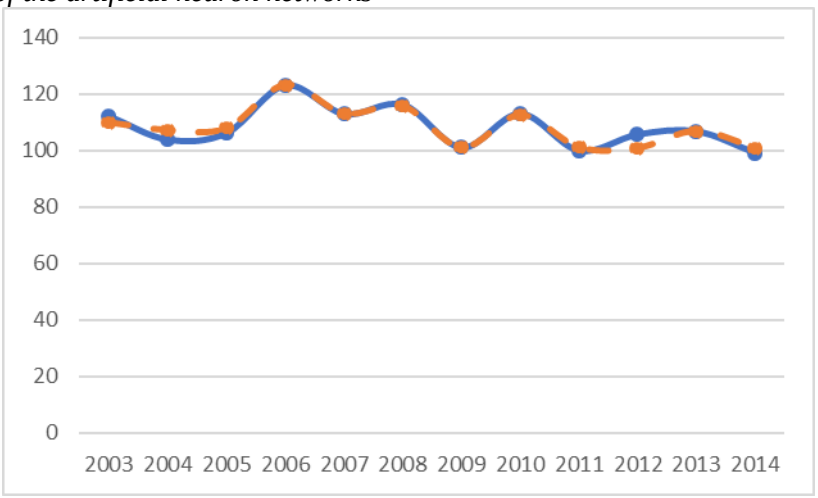


Table 4. *The value of verification criteria for the indicator "Actual monetary incomes of the population"(in percentages as compared to the previous year)*

Regression model		Artificial neuron network	
R2	Error	R2	Error
0.24	2.4%	0.92	2.2 %

4. Discussion

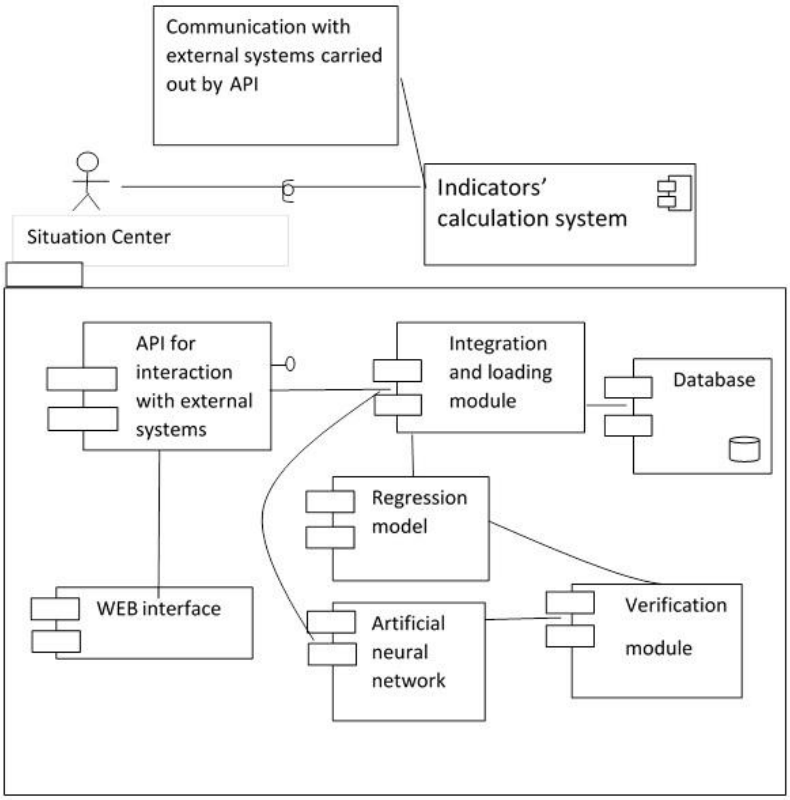
The developed system will be interconnected with the system of the situation center of Plekhanov RUE, which will make it possible to solve the tasks assigned to it more effectively. The interaction between the Contour BI system installed in the situation center and the forecasting system developed at the Informatics Department is shown in Figure 4.

This system architecture assumes the following possibilities:

1) The system will be accessed using the API.
2) The system will have a Web-based interface, but there will be an opportunity to work with the system directly using the API.
3) The data integration module will provide the preparation of data for processing and issuing the ready-made results from the database.
4) The "Regression model" module is a means of constructing the multiple linear regression for scenario forecasting.
5) The module for the artificial intelligence models will make it possible to use such methods as neural networks, genetic algorithms and others to solve the problems of forecasting.

6) The verification module will check the quality of the models constructed and, through fuzzy logic, issue the recommendations on the effectiveness of the aids used.
7) The system database will store the calculated indicators and the data for their further processing.

Figure 4. *Architecture of the system under development*



5. Conclusion

Thus, the system presented will allow performing operative monitoring of the regions of the Russian Federation. Due to the flexibility of the system, it will be possible to perform forecasting both at the regional and federal levels, as well as to use the time series in the annual, quarterly and monthly modes. The combination of different forecasting models will allow calculating one indicator in different ways.

In the future, elements of fuzzy logic will be added to the system, which will contribute to ranging the obtained models by relevance for the simulation of each specific time series. The verification will make it possible to evaluate the models obtained and to choose from them those which will enable to obtain the most qualitative and accurate forecast values of the indicators under study. The access to

the situation center system will allow downloading automatically the data from the Federal State Statistics Service, as well as visualizing the results of the calculations and generating reports.

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